

REMARKS

The Examiner is thanked for the thorough examination of the present application, and the indication that claim 41 contains allowable subject matter. The Office Action, however, tentatively rejected all remaining claims 1-2, 4-16, and 28-40. Applicant respectfully requests reconsideration in view of the remarks set forth herein.

35 U.S.C. 103(a)

Claims 1, 6, 7, 11, 13-15, 20, 21, 26, 28, 29, 33, 34, 38, and 40 stand rejected under 35 U.S.C. 103(a) as allegedly unpatentable over Bao et al. (US 6,455,417) in view of Chow (US 6,674,146). Claims 2, 16, and 30 stand rejected under 35 U.S.C. 103(a) as allegedly unpatentable over Bao et al. and Chow in view of Campana et al. (US 6,537,733). Claims 4, 18, and 31 stand rejected under 35 U.S.C. 103(a) as allegedly unpatentable over Bao et al. and Chow in view of Wong (US 20030224593). Claim 5, 19, and 32 stand rejected under 35 U.S.C. 103(a) as allegedly unpatentable over Bao et al. and Chow in view of Lu et al. (US 20020100693). Claims 8, 9, 12, 22-24, 27, 35, and 39 stand rejected under 35 U.S.C. 103(a) as allegedly unpatentable over Bao et al. and Chow in view of Li et al. (US 6,753,260). Finally, claims 10, 25, and 37 stand rejected under 35 U.S.C. 103(a) as allegedly unpatentable over Bao et al. and Chow in view of Kloster et al. (US 20020140103). Applicant respectfully traverses the rejections for at least the reasons discussed below.

Independent claims 1, 14, and 29 recite (respectively):

1. A semiconductor device, comprising:
a semiconductor substrate;
a first metal layer formed overlying the semiconductor substrate;
an etch stop layer formed overlying the first metal layer and the semiconductor substrate;
a dielectric layer formed overlying the etch stop layer; and

a second metal layer penetrating the dielectric layer and the etch stop layer and electrically connected to the first metal layer;
wherein, the etch stop layer has a dielectric constant smaller than 3.5;
wherein, the dielectric layer has a dielectric constant smaller than 3.0;
wherein the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer.

14. A copper damascene structure, comprising:
a semiconductor substrate;
a first copper layer formed overlying the semiconductor substrate;
an etch stop layer formed overlying the first copper layer and the semiconductor substrate;
a dielectric layer formed overlying the etch stop layer, in which a damascene opening is formed to penetrate the dielectric layer and the etch stop layer to expose the first copper layer; and
a second copper layer formed in the damascene opening and electrically connected to the first copper layer;
wherein, the etch stop layer has a dielectric constant smaller than 3.5;
wherein, the dielectric layer has a dielectric constant smaller than 3.0;
and
wherein the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer.

29. A fabrication method for a semiconductor device, comprising the steps of:
providing a semiconductor substrate having a first metal layer;
forming an etch stop layer overlying the first metal layer and the semiconductor substrate, wherein the etch stop layer has a dielectric constant smaller than 3.5;
forming a dielectric layer overlying the etch stop layer, wherein the dielectric layer has a dielectric constant smaller than 3.0;
forming an opening which penetrates the dielectric layer and the etch stop layer and exposes the first metal layer; and
forming a second metal layer in the opening, in which the second metal layer is electrically connected to the first metal layer.

(Emphasis added.) Applicant submits that each of independent claims 1, 14, and 29 patently define over the cited art for the reasons that the cited art fails to disclose at least those features emphasized above.

Significantly, none of the cited references teach or suggest the combination of “the etch stop layer has a dielectric constant smaller than 3.5”, “the dielectric layer has a dielectric constant

smaller than 3.0”, and “the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer”. In fact, the Office Action acknowledges that Bao et al. do not teach that the dielectric layer has a tensile stress approximating to the compressive stress of the etch stop layer.

Although the Chow reference appears to describe that a layer material with high compressive stress can be used with other layer materials having high tensile stress (column 2, lines 62-65), Chow does not suggest that “the etch stop layer having a dielectric constant smaller than 3.5”. In fact, Chow, teaches the barrier layer 130 (corresponding to the etch stop layer of the claimed embodiments) is cubic boron nitride (CBN) having a dielectric constant of 4-4.5. There is no teaching in Chow that would have suggested to an artisan that the dielectric layer could have a dielectric constant smaller than 3.0, and have a tensile stress approximating the compressive stress of the etch stop layer having a dielectric constant smaller than 3.5.

Indeed, Chow teaches that a layer material with high compressive stress can be used with other layer materials having high tensile stress, when one of the layer (the barrier layer 130) has a dielectric constant of 4-4.5. Significantly, Chow does not teach that a layer material with high compressive stress can be used with other layer materials having high tensile stress when “the etch stop layer has a dielectric constant smaller than 3.5” and when “the dielectric layer has a dielectric constant smaller than 3.0”. Thus, even if the disclosures of Bao et al. and Chow are combined, the claimed features of “the dielectric layer, having a dielectric constant smaller than 3.0, has a tensile stress approximating to the compressive stress of the etch stop layer, having a dielectric constant smaller than 3.5” are not properly taught in the combination, so as to render the claimed embodiments obvious.

In order to establish a prima facie case of obviousness, three criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teaching. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. See MPEP 2142.

As described, “the dielectric layer, having a dielectric constant smaller than 3.0, has a tensile stress approximating to the compressive stress of the etch stop layer, having a dielectric constant smaller than 3.5” of the claimed embodiments cannot reasonably be expected or achieved from the combination of Bao et al. and Chow. For at least these reasons, the rejections should be withdrawn.

As neither of the citations, when taken alone or in combination, teaches or suggests “the dielectric layer, having a dielectric constant smaller than 3.0, has a tensile stress approximating to the compressive stress of the etch stop layer, having a dielectric constant smaller than 3.5,” as defined in independent claims 1, 14, and 29, these claims are allowable over the cited references.

As a separate and independent basis for the patentability of claims 1, 14, and 29, Applicant respectfully traverses the rejections as failing to identify a proper basis for combining the cited references. In combining these references, the Office Action stated only that the combination would have been obvious “in order to minimize the effect of the tensile stress.” (Office Action, page 3). This alleged motivation is clearly improper in view of well-established Federal Circuit precedent.

It is well-settled law that in order to properly support an obviousness rejection under 35 U.S.C. § 103, there must have been some teaching in the prior art to suggest to one skilled in the art that the claimed invention would have been obvious. W. L. Gore & Associates, Inc. v. Garlock Thomas, Inc., 721 F.2d 1540, 1551 (Fed. Cir. 1983). More significantly,

"The consistent criteria for determination of obviousness is whether the prior art would have suggested to one of ordinary skill in the art that this [invention] should be carried out and would have a reasonable likelihood of success, viewed in light of the prior art. ..." Both the suggestion and the expectation of success must be founded in the prior art, not in the applicant's disclosure... In determining whether such a suggestion can fairly be gleaned from the prior art, the full field of the invention must be considered; for the person of ordinary skill in the art is charged with knowledge of the entire body of technological literature, including that which might lead away from the claimed invention."

(*Emphasis added.*) In re Dow Chemical Company, 837 F.2d 469, 473 (Fed. Cir. 1988).

In this regard, Applicant notes that there must not only be a suggestion to combine the functional or operational aspects of the combined references, but that the Federal Circuit also requires the prior art to suggest both the combination of elements and the structure resulting from the combination. Stiftung v. Renishaw PLC, 945 Fed.2d 1173 (Fed. Cir. 1991). Therefore, in order to sustain an obviousness rejection based upon a combination of any two or more prior art references, the prior art must properly suggest the desirability of combining the particular elements to derive a copper interconnect, as claimed by the Applicant.

When an obviousness determination is based on multiple prior art references, there must be a showing of some "teaching, suggestion, or reason" to combine the references. Gambro Lundia AB v. Baxter Healthcare Corp., 110 F.3d 1573, 1579, 42 USPQ2d 1378, 1383 (Fed. Cir. 1997) (also noting that the "absence of such a suggestion to combine is dispositive in an obviousness determination").

Evidence of a suggestion, teaching, or motivation to combine prior art references may flow, inter alia, from the references themselves, the knowledge of one of ordinary skill in the art, or from the nature of the problem to be solved. See In re Dembiczak, 175 F.3d 994, 1000, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999). Although a reference need not expressly teach that the disclosure contained therein should be combined with another, the showing of combinability, in whatever form, must nevertheless be "clear and particular." Dembiczak, 175 F.3d at 999, 50 USPQ2d at 1617.

If there was no motivation or suggestion to combine selective teachings from multiple prior art references, one of ordinary skill in the art would not have viewed the present invention as obvious. See In re Dance, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998); Gambro Lundia AB, 110 F.3d at 1579, 42 USPQ2d at 1383 ("The absence of such a suggestion to combine is dispositive in an obviousness determination.").

Significantly, where there is no apparent disadvantage present in a particular prior art reference, then generally there can be no motivation to combine the teaching of another reference with the particular prior art reference. Winner Int'l Royalty Corp. v. Wang, No 98-1553 (Fed. Cir. January 27, 2000).

For at least the additional reason that the Office Action failed to identify proper motivations or suggestions for combining the various references to properly support the rejections under 35 U.S.C. § 103, the rejections of claims 1, 14, and 29 should be withdrawn.

Insofar as claims 2 and 4-13, 15-16 and 18-28, and 30-40 depend from claims 1, 14, and 29, these claims are also allowable for at least the same reasons.

CONCLUSION

In light of the foregoing amendments and for at least the reasons set forth above, Applicant respectfully submits that all objections and/or rejections have been traversed, rendered moot, and/or accommodated, and that the now pending claims 1-2 and 4-41 are in condition for allowance. Favorable reconsideration and allowance of the present application and all pending claims are hereby courteously requested. If, in the opinion of the Examiner, a telephonic conference would expedite the examination of this matter, the Examiner is invited to call the undersigned agent at (770) 933-9500.

No fee is believed to be due in connection with this amendment and response to Office Action. If, however, any fee is believed to be due, you are hereby authorized to charge any such fee to deposit account No. 20-0778.

Respectfully submitted,


Daniel R. McClure, Reg. No. 38,962

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.
Suite 1750
100 Galleria Parkway N.W.
Atlanta, Georgia 30339
(770) 933-9500